

REMARKS

I. Introduction

By the present Amendment, claims 15, 21, and 24 have been amended. Claims 1-5, 7, 8, 10-12, 14, and 17-20 have been cancelled. Accordingly, claims 15, 16, and 21-24 remain pending in the application. Claims 15 and 24 are independent.

II. Office Action Summary

In the Office Action of September 3, 2008, claims 1, 3, 7-10, 12, 15, 17, 22, and 23 were rejected under 35 USC §102(b) as being anticipated by Japanese Patent No. JP 2001-085308 to Kudo. Claims 1, 2, 4, 8-11, 13, 15, 16, and 18 were rejected under 35 USC §102(b) as being anticipated by Japanese Patent No. JP 05-045605 to Abe et al. Claims 2, 4-6, 11, 13, 14, 16, and 18-21 were rejected under 35 USC §103(a) as being unpatentable over Kudo. The cancellation of claims 1-5, 7, 8, 10-12, 14, and 17-20 has rendered most of these grounds of rejection moot. Regarding the remaining claims, these rejections are respectfully traversed.

III. Rejections under 35 USC §102

Claims 15, 16, 22, and 23 were rejected under 35 USC §102(b) as being anticipated by either Kudo or Abe. Regarding this rejection, the Office Action indicates, for example, that Kudo and Abe both disclose a method of illumination that includes emitting light from each of a plurality of light sources, a fiber bundle that has a plurality of light sources, spatially decomposing the light emitted by means of an integrator to form a multitude of pseudo-secondary light sources, and overlapping the light emitted by means of a condenser lens. Applicants respectfully disagree.

At the outset, Applicants note that the Office Action has failed to make a prima facie case of anticipation inasmuch as the rejection does not even attempt to address all the limitations that are clearly recited in, for example, independent claim 15. Furthermore, the Office Action has completely failed to address the existence of claim 24. In any event, Applicants have amended the claims to better define the invention and recite features that are clearly not shown or suggested by the art of record.

As amended, independent claim 15 defines a light exposure apparatus that comprises:

an illumination optical system including:

a light source array formed of a plural separate semiconductor laser diodes arranged one-dimensionally or two-dimensionally;

a condensing optical system for condensing light emitted from each semiconductor laser diode of said light source array;

a light integrator for spatially decomposing the light condensed by said condensing optical system, and thus generating a multitude of secondary light source images; and

a condenser lens for overlapping the light rays emitted from the multitude of secondary light source images generated by said light integrator, and thus illuminating an illumination target region having a pattern to be exposed; and

a projection optical system for projecting transmitted or reflected light onto an exposure target region of an exposure target object in order to expose the pattern to be exposed that is illuminated by said illumination optical system; and

wherein said illumination optical system further includes divergence angle adjusting optical system which divergence angles in the light flux emitted from each of the semiconductor laser diodes are adjusted to stay within a ration of 1 versus 1.5 with respect to any two direction with a plane vertical to an optical axis of the emitted light flux; and

wherein said illumination optical system further includes a rotating modulator formed by rotating a glass disc which is processed (polished) in a radical form so that its surface height

shape in each section repeated in circumference direction varies in nearly a sinusoidal fashion and the surface height variation is several microns, on the incident side or exit side of said light integrator to prevent generation (occurrence) of interference fringes on the overlapped illumination target region.

The light exposure apparatus of independent claim 15 includes an illumination optical system, and a projection optical system that projects transmitted or reflected light onto an exposure target region of an exposure target object in order to expose the pattern that is illuminated by the illumination optical system. The illumination optical system includes a light source array that is formed of plural semiconductor laser diodes that are separate and arranged either one dimensionally or two dimensionally. A condensing optical system is provided for condensing light emitted from each of the semiconductor laser diodes, and a light integrator is provided for spatially decomposing the light condensed by the condensing optical system in order to generate a multitude of secondary light source images. A condenser lens is also provided for overlapping the light rays emitted from the multitude of secondary light source images in order to illuminate an illumination target having a pattern to be exposed. According to independent claim 15, the illumination optical system further includes a divergence angle adjusting optical system which causes divergence angles in the light flux emitted from each of the semiconductor laser diodes to be adjusted to stay within a ratio of 1 to 1.5 with respect to any two directions on a plane vertical to an optical axis of the emitted light flux. Furthermore, a rotating modulator is formed by rotating a glass disc which is processed (or polished) in a radical form so that its surface height shape in each section that is repeated in the circumferential direction varies in nearly a sinusoidal fashion. The surface height variation is also several microns on the incident side or exit side of the light integrator in order to

prevent generation (or occurrence) of interference fringes on the overlapped illumination target region. See paragraphs [0056] to [0058] of the published application and Figs. 7-9. According to such an arrangement, it is possible to achieve high performance illumination using reduced energy in order to efficiently irradiate an object using the multiple semiconductor laser diodes, because each individual semiconductor laser diode utilizes a small amount of energy. Most of the modulated light can therefore reach the entrance plane of the light integrator or overlapped illumination target region by rotation of the rotating modulator. Furthermore, the laser diode array can be constructed by arranging blue or purple semiconductor lasers having a wavelength of nearly 405 nm (380-420 nm) with an output of about mW. See paragraph [0037].

The Office Action alleges that Kudo and Abe individually disclose all the features recited in independent claim 15. Applicants' review of these references, however, has failed to reveal any disclosure or suggestion for a plurality of separate semiconductor laser diodes that are arranged as a light source array. Furthermore, these references do not appear to provide a divergence angle adjusting optical system that includes, for example, a pair of cylindrical lenses (112, 113) as set forth in the present invention. See paragraphs [0046] and [0047] of the published application. More particularly, the cited references do not appear to provide any disclosure or suggestion for features now recited in independent claim 1, such as:

wherein said illumination optical system further includes divergence angle adjusting optical system which divergence angles in the light flux emitted from each of the semiconductor laser diodes are adjusted to stay within a ration of 1 versus 1.5 with respect to any two direction with a plane vertical to an optical axis of the emitted light flux; and

wherein said illumination optical system further includes a rotating modulator formed by rotating a glass disc which is

processed (polished) in a radical form so that its surface height shape in each section repeated in circumference direction varies in nearly a sinusoidal fashion and the surface height variation is several microns, on the incident side or exit side of said light integrator to prevent generation (occurrence) of interference fringes on the overlapped illumination target region.

It is therefore respectfully submitted that independent claim 15 is allowable over the art of record.

Claims 16 and 21-23 depend from independent claim 15, and are therefore believed allowable for at least the reasons set forth above with respect to independent claim 15. In addition, these claims each introduce novel elements that independently render them patentable over the art of record.

By the present Amendment, Applicants have amended independent claim 24 to define a rotating modulator which varies the wavefronts of light. The rotating modulator comprises:

a rotating modulator formed by rotating a glass disc which is processed (polished) in a radical form so that its surface height shape in each section repeated in circumference direction varies in nearly a sinusoidal fashion and the surface height variation is several microns, on the incident side or exit side of said light integrator to prevent generation (occurrence) of interference fringes on the overlapped illumination target region.

The rotating modulator of independent claim 24 includes a rotating modulator that is formed by rotating a glass disc processed in a radical form such that its surface height shape in each section repeated in the circumference direction varies in nearly a sinusoidal fashion and the surface height variation is several microns on the incident side or exit side of the light integrator in order to prevent the occurrence of interference fringes on the overlapped illumination target region.

As previously discussed with respect to independent claim 15, this particular feature does not appear to be disclosed or discussed by the art of record.

It is therefore respectfully submitted that independent claim 24 is allowable over the art of record.

IV. Conclusion

For the reasons stated above, it is respectfully submitted that all of the pending claims are now in condition for allowance. Therefore, the issuance of a Notice of Allowance is believed in order, and courteously solicited.

If the Examiner believes that there are any matters which can be resolved by way of either a personal or telephone interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

AUTHORIZATION

Applicants request any shortage or excess in fees in connection with the filing of this paper, including extension of time fees, and for which no other form of payment is offered, be charged or credited to Deposit Account No. 01-2135 (Case: 500.44257X00).

Respectfully submitted,
ANTONELLI, TERRY, STOUT & KRAUS, LLP.

_____/Leonid D. Thenor/
Leonid D. Thenor
Registration No. 39,397

LDT/vvr
1300 N. Seventeenth Street
Suite 1800
Arlington, Virginia 22209
Tel: 703-312-6600
Fax: 703-312-6666

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